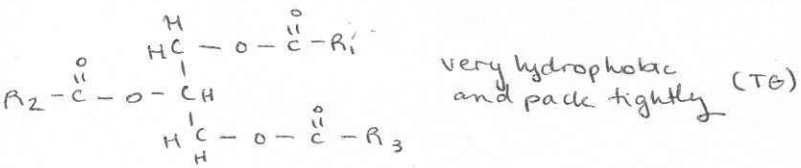
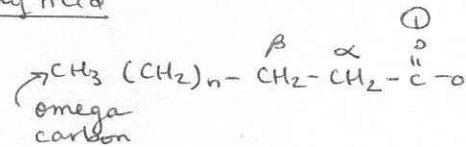


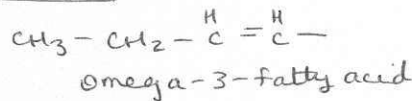
Fatty Acids (Oxidation occurs in mitochondria)



Fatty Acid



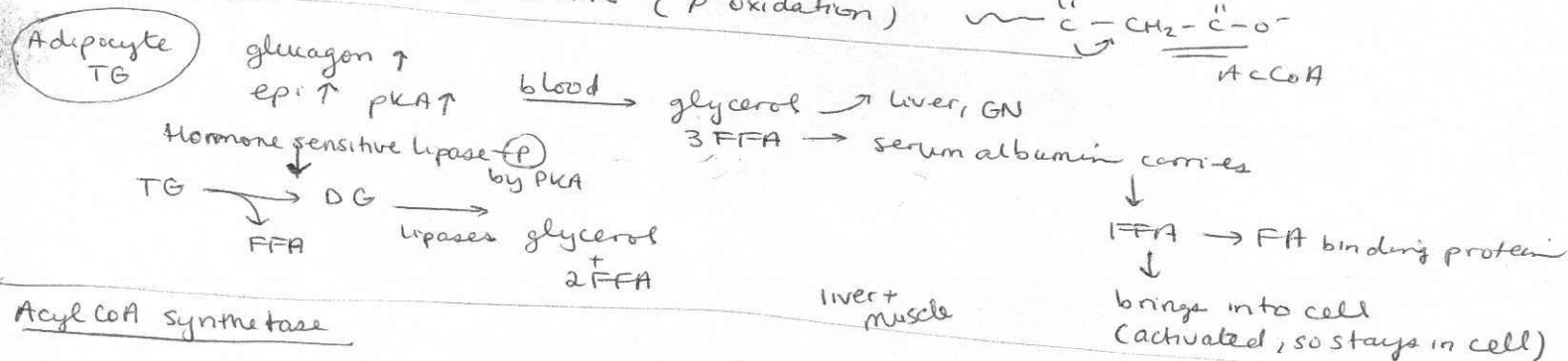
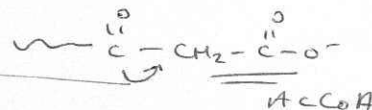
Omega series



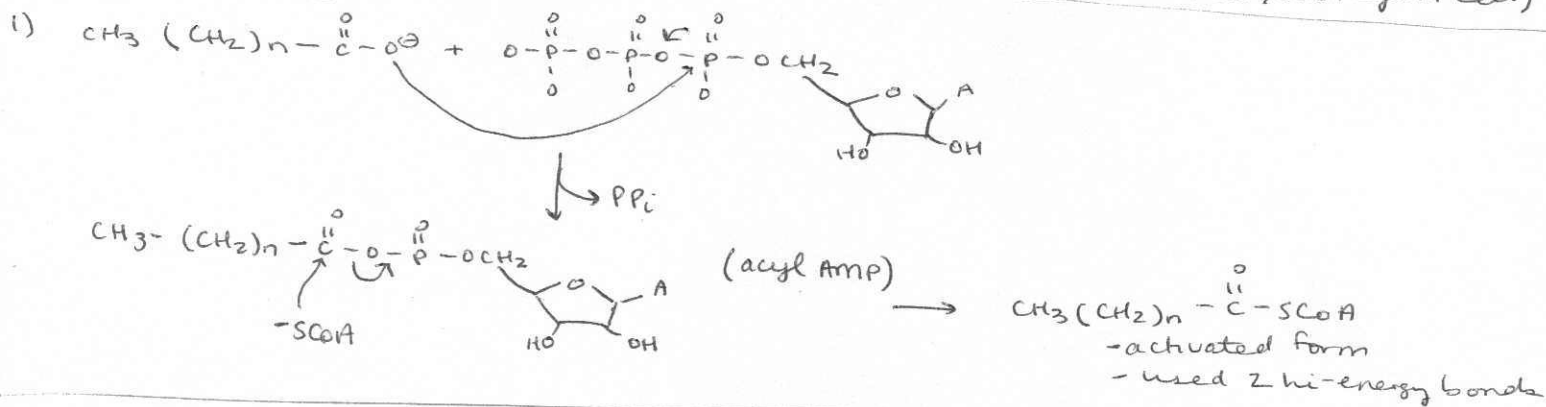
- C16:0 palmitic acid, hexadecanoic acid
- C18:0 stearic acid, octadecanoic acid
- cis Δ9 C18:1 oleic acid, cis Δ9 octadecenoic acid

- cis Δ5,8,11,14 C20:4 arachidonic acid, cis Δ5,8,11,14 eicosatetraenoic acid
- cis Δ9,12, C18:2 Linoleic Acid (omega 6)
- cis Δ9,12,15 C18:3 Linolenic acid (omega 3)

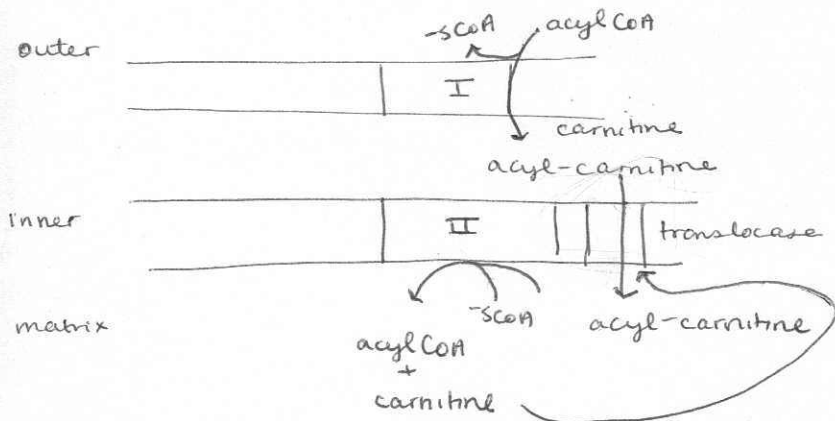
* Oxidations work 2 carbons at a time (β-oxidation)



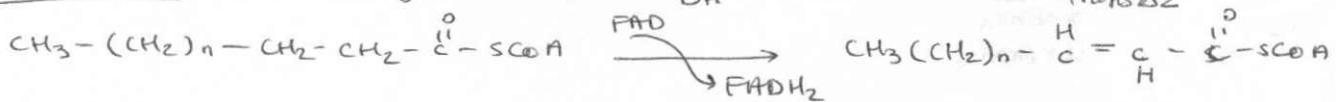
Acyl CoA Synthetase



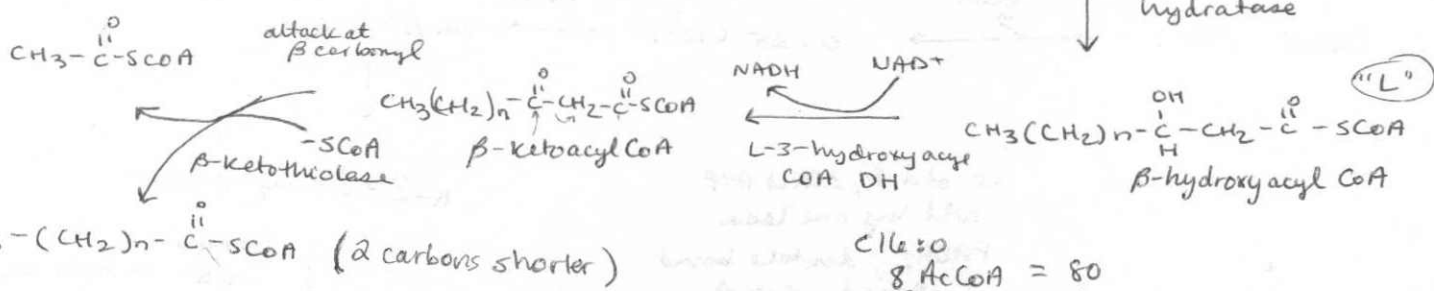
Acyl carnitine translocase (I+II: carnitine-acyl-transferase, CAT-1, CAT-2)



β-oxidation (even#, fully saturated)



$\downarrow \text{H}_2\text{O}$
enoyl CoA hydratase

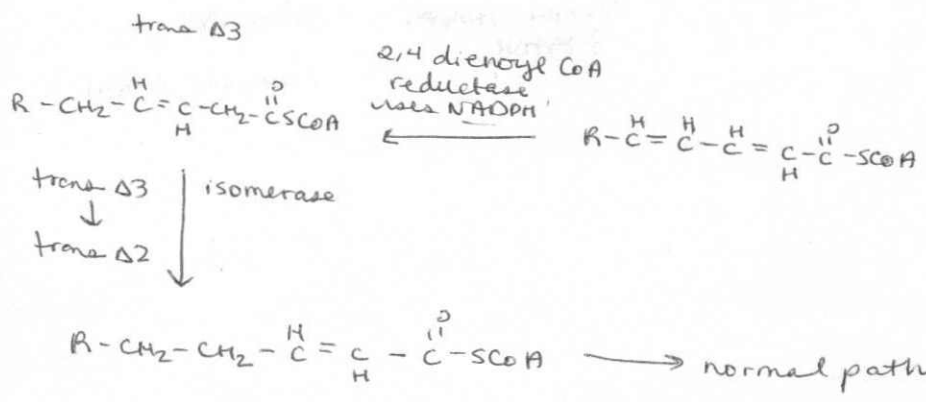
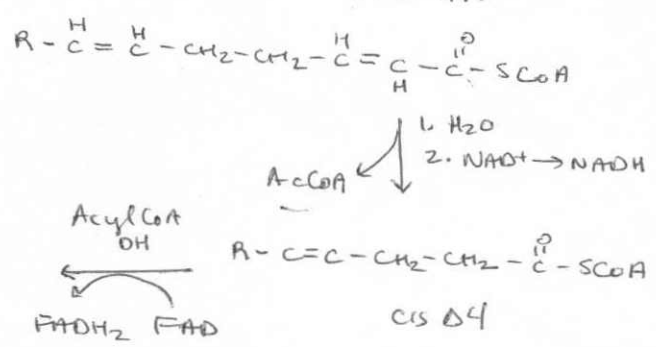
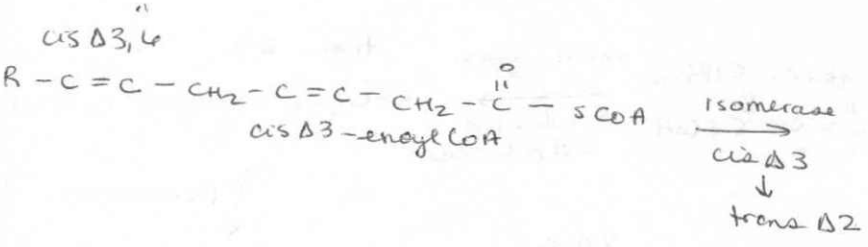


Energy Yield

~~Stearic~~ Stearic Acid C18:0



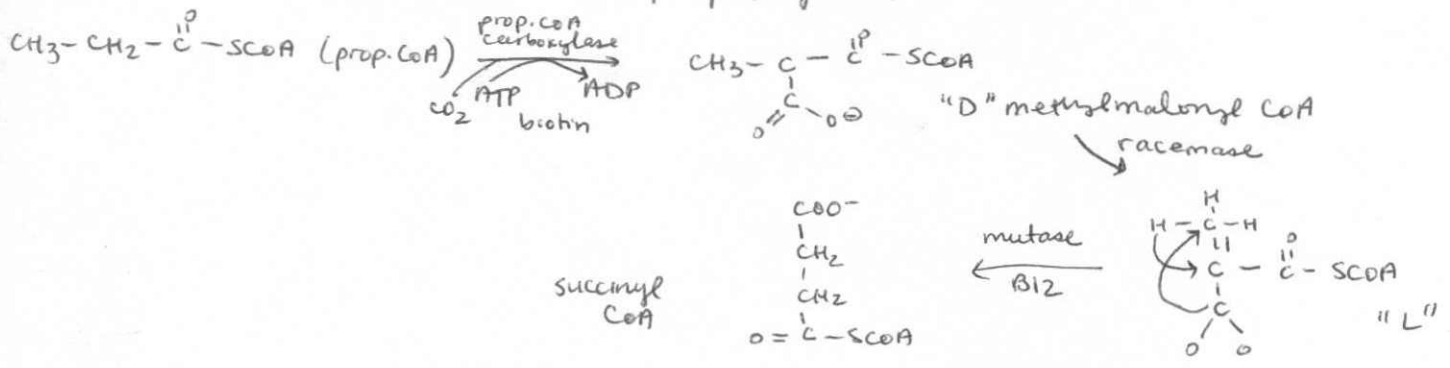
C16:0
8 AcCoA = 80
7 FADH₂ = 10.5
7 NADH₂ = 17.5
108 - 2 = 106 ATP
(acyl CoA step)
90
20
12
122
- 2 activ
120 ATP

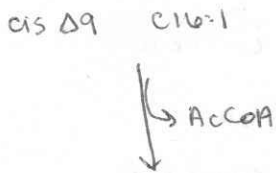


Cis Δ⁹ C18:1 → 118.5 ATP (1 less FADH₂)
Cis Δ¹² C18:1 → 117.5 ATP (1 less NADH)
Cis Δ^{9,12} C18:2 → 116.0 ATP (1 less FADH₂ + NADH)

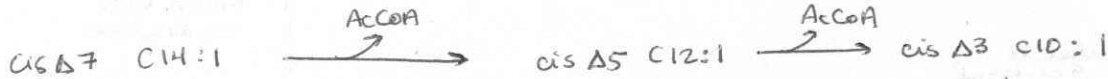
VLCAD O₂ → H₂O₂ (no FADH₂)

C17:0: 7 AcCoA, 7 NADH, 7 FADH₂ + propionyl CoA

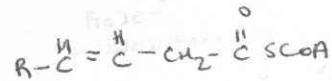




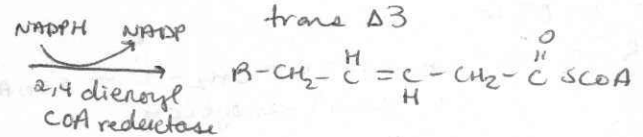
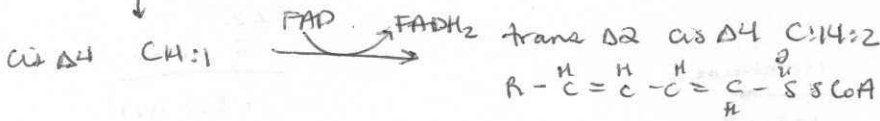
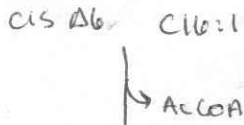
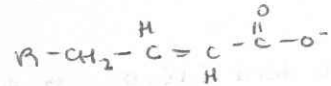
8 AcCoA
 7 NADH
 6 FADH₂



at odd #, affect ATP
 yield by one less
 FADH₂, double bond
 is already there



isomerase
 cis Δ3 → trans Δ2

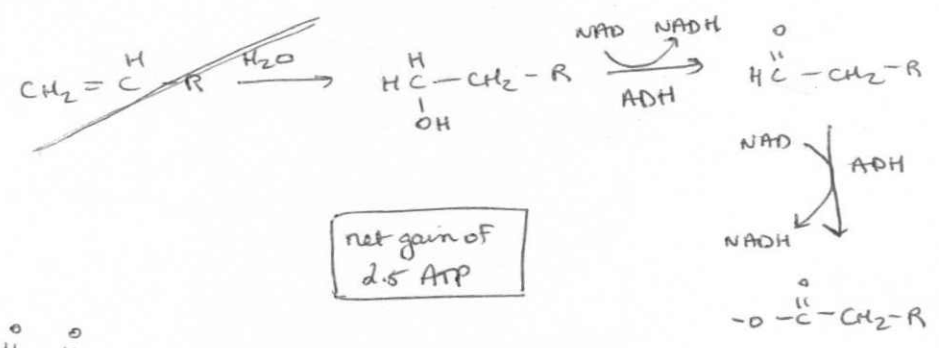
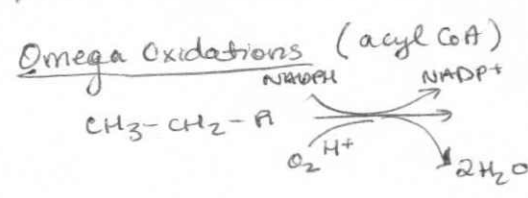


isomerase

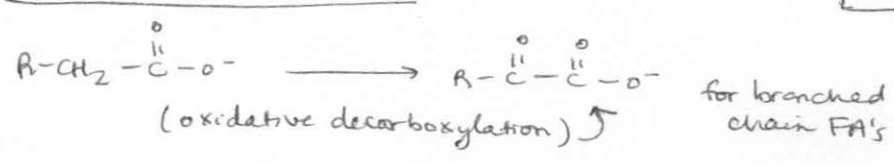
8 AcCoA
 7 NADH - 1 NADPH
 7 FADH₂

trans Δ2
 (one less NADH)

Minor Oxidations



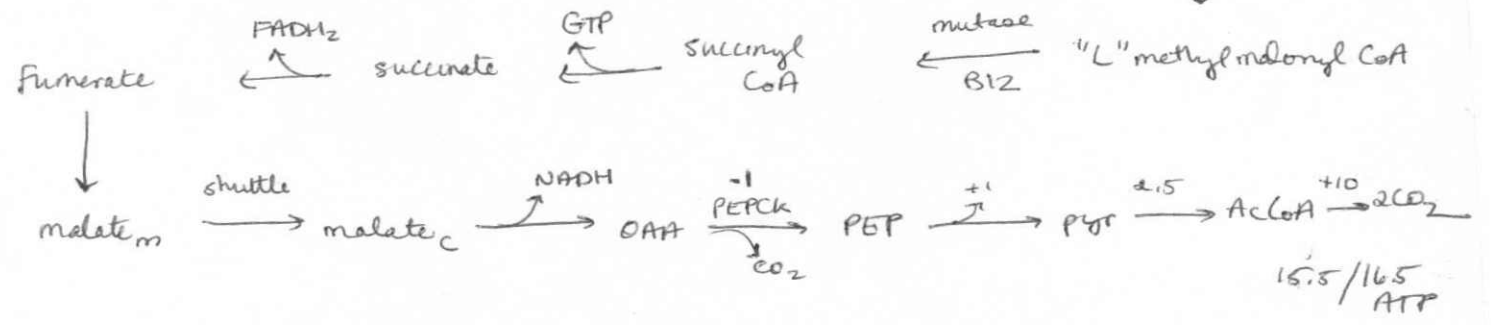
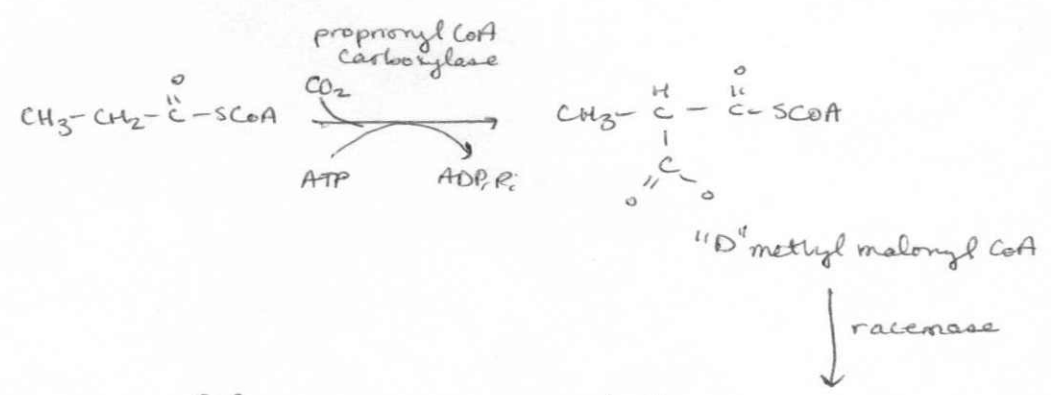
α-oxidation (peroxisomal)



net gain of 2.5 ATP

Odd Chain FA's

C17:0 7 AcCoA
7 NADH
7 FADH₂
propionyl CoA

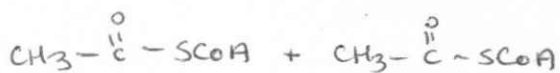


Fatty Acid Regulation (oxidation)

- CPT-1 : inhibited by high levels of malonyl CoA $-\text{O}-\text{C}(=\text{O})-\text{CH}_2-\text{C}(=\text{O})-\text{SCoA}$
- HSL : ↑ by PKA and is active. Slightly inhibited by ketone bodies

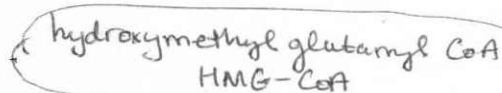
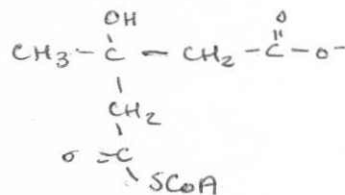
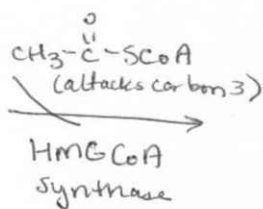
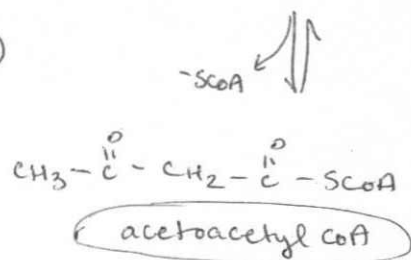
Ketone Bodies (when FA oxidation is extensive, Fasting conditions)

(17)



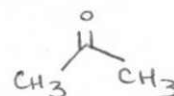
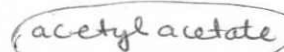
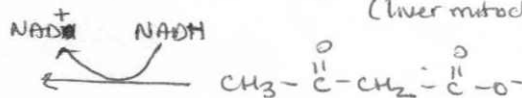
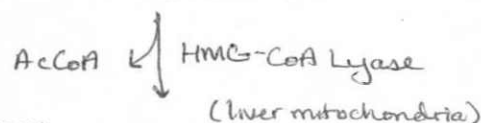
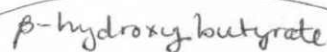
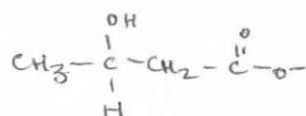
- AcCoA levels very high in mitochondria
- NADH also very high, so TCA cycle slows

(matrix)

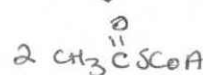
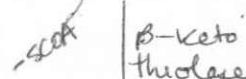
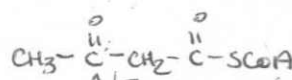
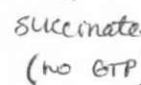
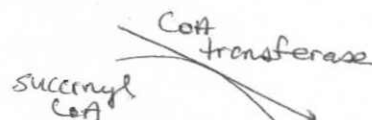
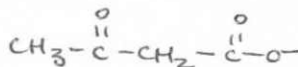
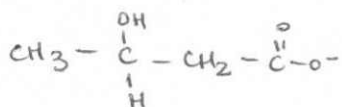


Ketone Bodies used by:

- muscle
- kidney
- brain



Energy yield



Net Energy Gain:

$$2 \text{ AcCoA} = 20 \text{ ATP}$$

$$- 1 \text{ ATP}$$

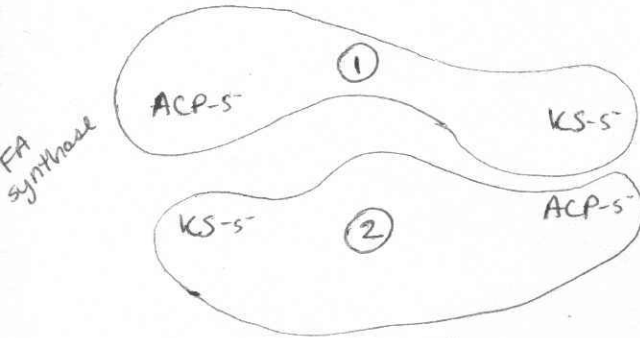
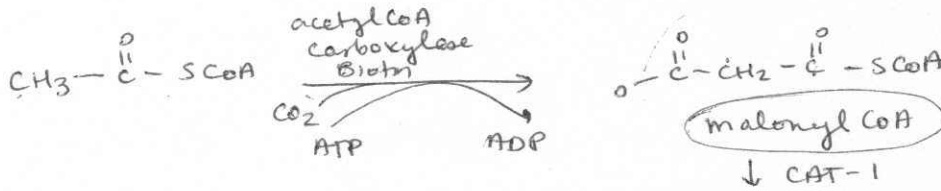
$$\hline 19 \text{ ATP}$$

Fatty Acid Synthesis

FA Synthase: Dimer, 7 activities

(18)

- 1) Acetyl CoA carboxylase (\uparrow with insulin release)
- 2) Fatty Acid Synthase



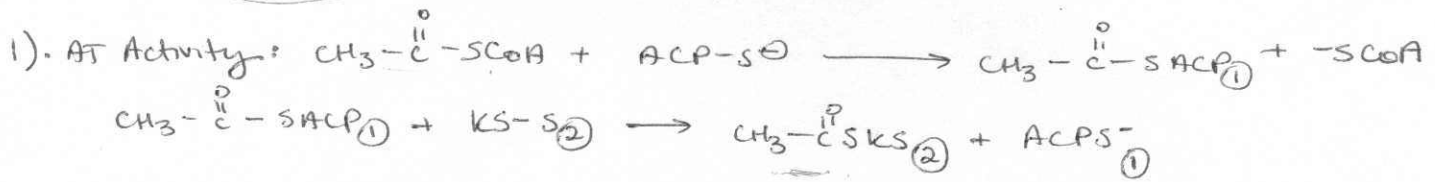
ACP = acyl carrier protein

KS = ketoacyl Synthase - forms new C-C

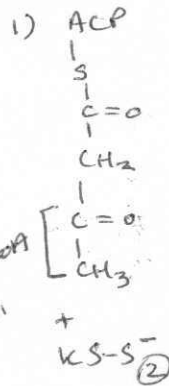
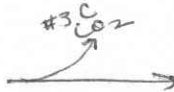
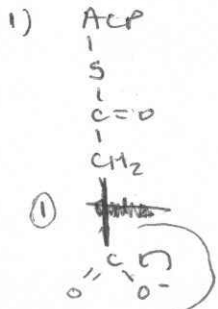
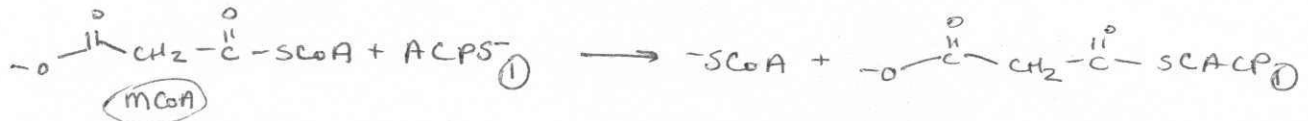
AT = acetyl ~~transacylase~~

MT = malonyl transacylase

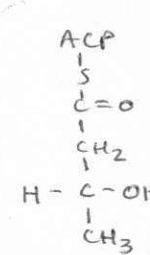
ACP - phosphopantetheine



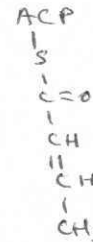
2) MT:



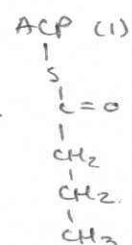
KR
Ketoacyl
reductase



dehydratase
 $\xrightarrow{\text{H}_2\text{O}}$

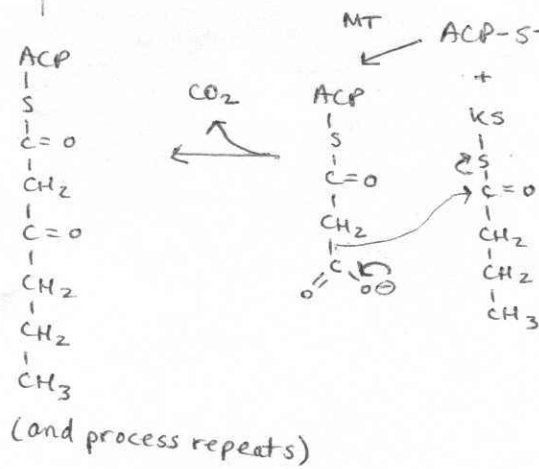


NADPH
Enoylacyl
reductase



+ KS-S⁻ (2)

Thiolase (TE) hydrolyzes
S-C bond
 \downarrow
Free palmitic acid
 \downarrow activated



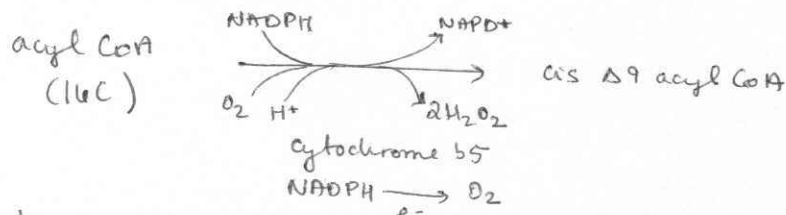
Activated Palmitic Acid

Elongation - ER (acyl-CoA, malonyl CoA, NADPH)



Desaturation - ER

only can put double bonds at 5, 6, 9



• humans only make omega 7

• 2 essential FA's

linoleic cis $\Delta^9, 12$, C18:2 (omega 6)

linolenic cis $\Delta^9, 12, 15$ C18:3 (omega 3)

=> • 2nd messengers
• prostaglandins
• thromboxanes
• Leukotrienes

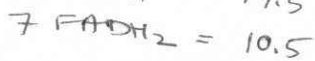
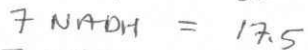
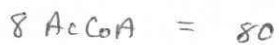
Energy Required to make FA

(Palmitic Acid) C16:0



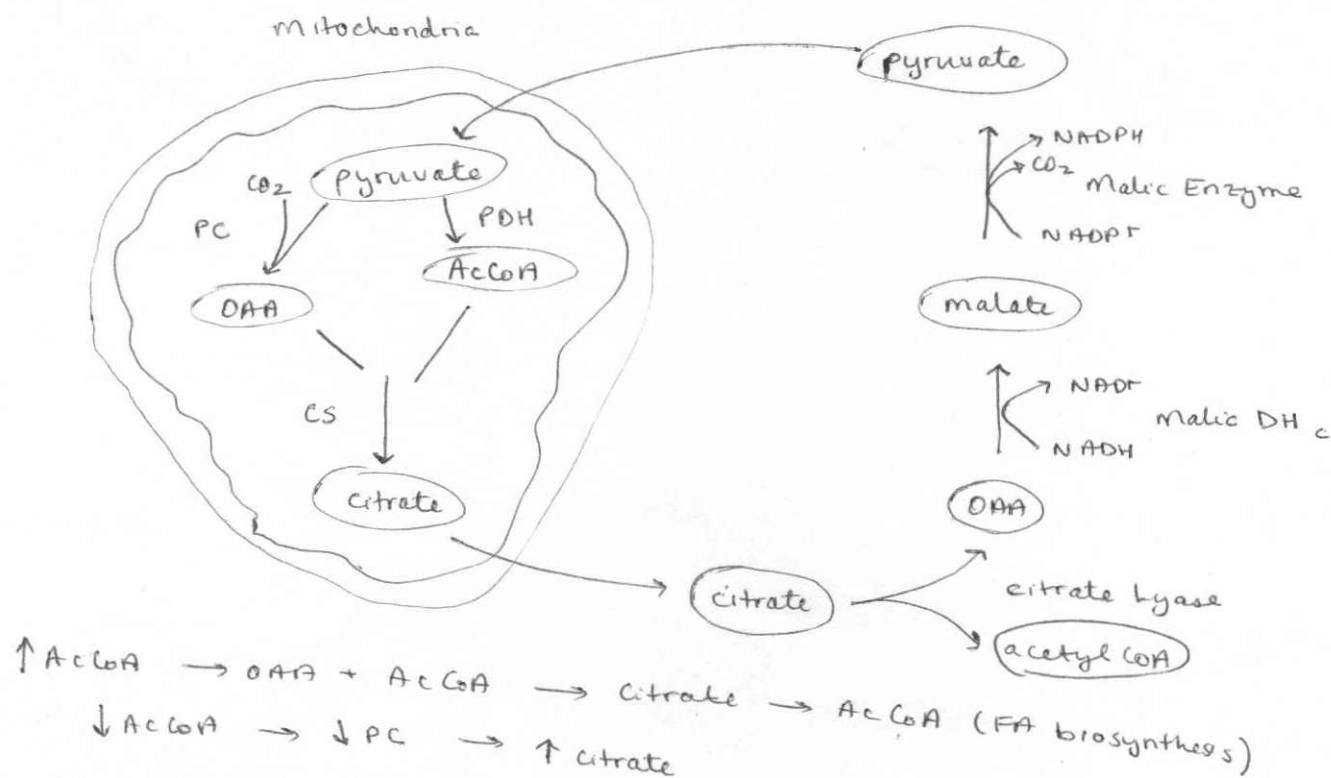
122 ATP

Oxidize C16:0



108 - 2 = 106

$\frac{106}{122} = 85\% \text{ efficiency}$



Regulation of FA Synthesis

- Signal to start

citrate ↑ AcCoA Carboxylase

TCA ↑ NADH buildup, citrate builds up

muscle { AcCoA Carboxylase -P ↓ by AMP-activated protein kinase
 Malonyl CoA deCarboxylase -P ↑ " " (gets rid of malonyl CoA when low energy)

- muscle can reduce or speed up use of FA's

Long term adaptation (eat too much)

↑ AcCoA Carboxylase
 FA Synthase
 Citrate lyase
 Malic Enzyme
 GlcP DH

FA Synthase - weakly inhibited by palmitoyl CoA